FORM PTO-1390 (REV. 9-2001) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER: FORSAL-26

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 10/009038

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FI00/00320	April 14, 2000	April 28, 1999

TITLE OF INVENTION: Method and Apparatus for Mixing Dilution Liquid into a Stock in a Paper or Board Machine

APPLICANT(S) FOR DO/EO/US: Juhana Lumiala

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [X] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [X] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [X] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [ ] Other items or information:

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/009038		

21. [X] The following fees are submitted:	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 1040.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	11- 20 =	0	x **$18.00**	$ 0.00	
Independent claims	3 - 3 =	0	x **$84.00**	$ 0.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**	$	
TOTAL OF ABOVE CALCULATIONS =				$	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$	
SUBTOTAL =				$	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$	
TOTAL NATIONAL FEE =				$	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 1040.00	
				Amount to be refunded:	$
				charged:	$

a. [X] A check in the amount of $ 1040.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 15-0660 . A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

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David R.J. Stiennon
SIGNATURE

David R.J. Stiennon
NAME

33212
REGISTRATION NUMBER

In The United States Patent And Trademark Office

Applicant: Juhana Lumiala Date: October 25, 2001

Date Filed: Simultaneously herewith Docket No.: FORSAL-26

PCT App. No.: PCT/FI00/00320

For: Method and Apparatus for Mixing Dilution Liquid into a Stock Flow in a Paper or Board Machine

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David R. J. Stiennon
Signature
David R. J. Stiennon, Reg. No. 33212
Name of applicant, assignee or Registered Representative

Preliminary Amendment

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to examination of the above application, please amend the application as follows.

In the Specification:

Please amend the specification as shown on the accompanying Clean Copy of Substitute Specification. A Marked Up Copy of Substitute Specification is also provided, as well as a Statement as to Lack of New Matter under 37 C.F.R. 1.125(b)(1).

In the Claims:

Please cancel claims 1-7 and add the following new claims.

8. A method for passing dilution water into connection with a stock flow passed from a stock inlet header of a headbox in a paper or board machine, wherein dilution is carried out in at least two stages using in a first dilution stage first valves fitted with a larger mutual spacing at different points of width across the headbox and passing the dilution water through said first valves to desired points of width of the headbox according to the requirement of control of the basis weight of paper or board, and wherein in a second dilution stage (II), dilution water is passed into connection with a stock flow coming from the first dilution stage, said dilution water being controlled by means of second valves, the second valves being fitted with a denser spacing than the first valves of the first dilution stage, and that coarse control of the basis weight profile of the stock is carried out in the first dilution stage and fine control of the basis weight profile of the stock is carried out in the second dilution stage across the width of the machine.

9. The method of claim 8 wherein the dilution water used in the second stage of dilution has a solids, filler or fibre content which is substantially lower in percentage terms than that of the dilution water of the first stage of dilution.

10. The method of claim 8 wherein the dilution water used in the second dilution stage is selected from the group consisting of raw water and clarified white water.

11. The method of claim 8 wherein the dilution water of the first stage is white water.

12. A headbox of a paper or board machine comprising:

a stock inlet header;

a tube bank after the stock inlet header;

an intermediate chamber after the tube bank;

a turbulence generator after the intermediate chamber;

a slice cone after the turbulence generator from which stock is passed further onto a forming wire;

a plurality of first valves of a first dilution stage, through which dilution water is passed into connection with the stock passed from the inlet header to desired points across the width of the headbox so as to control the basis weight of the web in the first stage; and

a plurality of second valves of a second dilution stage, through which the dilution water of the second stage is passed into connection with the stock coming from the first dilution stage, wherein the first valves of the first dilution stage are spaced a longer distance from one another than the second valves of the second dilution stage, in which connection coarse control of the basis weight of the web is carried out by means of the first valves of the first dilution stage and fine control of the basis weight of the web is carried out by means of the second valves of the second dilution stage.

13. The headbox of claim 12 wherein the dilution water of the first dilution stage is passed into connection with the stock passed from the stock inlet header in connection with the tube bank, and that the dilution water of the second dilution stage is passed into connection with the stock coming from the first dilution stage in connection with the turbulence generator.

14. The headbox of claim 12 furthere comprising an inlet header for the dilution water of the second dilution stage, said inlet header supplying raw water as dilution water.

15. A method for controlling the basis weight profile of a stock flow across the width of a papermaking machine headbox, comprising the steps of:

passing dilution water into the stock flow from a stock inlet header of the headbox, the dilution water being passed through a plurality of first valves spaced a first distance apart to points of width of the headbox to produce a first stage diluted stock flow in which coarse control of the basis weight profile of the stock is carried out; and

passing dilution water into the first stage diluted stock flow through a plurality of second valves, the second valves being spaced apart a second distance which is less than the first distance to produce a second stage diluted stock flow in which fine control of the basis weight profile of the stock is carried out across the width of the machine.

16. The method of claim 15 wherein the dilution water used in the second stage of dilution has a solids, filler or fibre content which is substantially lower in percentage terms than that of the dilution water of the first stage of dilution.

17. The method of claim 15 wherein the dilution water used in the second dilution stage is selected from the group consisting of raw water and clarified white water.

18. The method of claim 15 wherein the dilution water of the first stage is white water.

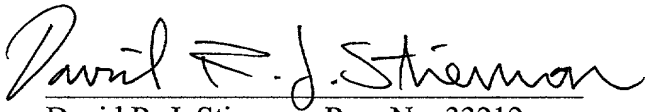
REMARKS

Claims 8–18 remain pending in the application.

PCT App. No.; PCT/FI00/00320
Filed: October 26, 2001

Applicant believes that no new matter has been added by these amendments and that the application, as amended, is ready for examination. Favorable action thereon is respectfully solicited.

Respectfully submitted,



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In The United States Patent And Trademark Office

Applicant: Juhana Lumiala Date: October 26, 2001

Date Filed: Simultaneously herewith Docket No.: FORSAL-26

PCT App. No.: PCT/FI00/00320

For: Method and Apparatus for Mixing Dilution Liquid into a Stock Flow in a Paper or Board Machine

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David R. J. Stiennon

Signature

David R. J. Stiennon, Reg. No. 33212

Name of applicant, assignee or Registered Representative

Statement as to Lack of New Matter under 37 C.F.R. 1.125(b)(1)

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

The accompanying Substitute Specification under 37 C.F.R. 1.125(b)(1) includes no new matter.

Respectfully submitted,

David R. J. Stiennon

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In The United States Patent And Trademark Office

Applicant: Juhana Lumiala Date: October 26, 2001

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For: Method and Apparatus for Mixing Dilution Liquid into a Stock Flow in a Paper or Board Machine

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David R. J. Stiennon
Signature
David R. J. Stiennon, Reg. No. 33212
Name of applicant, assignee or Registered Representative

Clean Copy of Substitute Specification under 37 C.F.R. 1.125(c)

TITLE OF THE INVENTION

Method and Apparatus for Mixing Dilution Liquid into a Stock Flow in a Paper or Board Machine

CROSS REFERENCES TO RELATED APPLICATIONS

This application is a U.S. national stage application of PCT Application No. PCT/FI00/00320, filed 14 April 2000, and claims priority on Finnish Application No. 990967, filed April 28, 1999, the disclosures of both of which applications are incorporated by reference herein.

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

Not applicable.

BACKGROUND OF THE INVENTION

The invention relates to a method and an apparatus for mixing dilution liquid into a stock flow in a paper or board machine.

With respect to the prior art, we refer to the publications DE 19723861 and FI 901593.

It has become clear that with the development of measuring devices on the market ever higher requirements are set for the accuracy of control of the basis weight profile. Today, the dilution spacing in a so-called dilution headbox is about 32-75 mm, and it is not possible to reduce it any more if fibre-containing white water is used as dilution water, because dilution feed ducts which remain open by means of white water cannot be accommodated between tube rows with a dense spacing.

SUMMARY OF THE INVENTION

As a solution it is proposed that, when needed, dilution is changed to comprise two stages such that coarse control is carried out by means of white water and fine control is carried out by means of raw water.

The increasing requirement of control accuracy calls for an increasingly denser dilution spacing and, therefore, still narrower dilution feed ducts. If white water is used as dilution water, narrow dilution ducts clog easily. Clogging problems are not encountered with raw water, but its "full-scale use" is not economical and sensible for environmental reasons.

The idea of the two-stage dilution is to correct large basis weight profile errors by a large amount of white water and small profile errors by a small amount of raw water. A good raw water economy is achieved by this means in a paper mill. Another benefit of the two-stage arrangement is the good possibility of adjusting the basis weight profile. The entire valve control area can be made use of and control valves of an optimum size can be selected for both control operations.

Coarse control is carried out in a tube bank after an inlet header, as in the conventional headbox. In the first dilution stage, the control spacing can be increased, for example, to 120 mm such that one dilution member feeds two tube rows. Course control corrects major errors in the shape of the profile, such as, for example, profile errors arising from web shrinkage. The small errors which remain in the profile after coarse control are rectified by means of fine control dilution in the second stage.

Fine adjustment is carried out as turbulence generator dilution by supplying some or each of the tubes of the turbulence generator with dilution liquid. A very small amount of dilution liquid is needed for rectifying the remaining small errors, so raw water or clarified white water obtained from a fibre recovery unit can be used economically as dilution water in fine control. Since, for example, raw water does not contain contaminating or clogging particles, the dilution ducts can be provided in very narrow spaces. Moreover, the control valves and the actuators operating the valves can be ordinary standard devices available on the market, which devices are considerably less expensive than conventional dilution valves and actuators.

Minimum local dilution with raw water can be almost 0 % and maximum local dilution need not be high because the consistency of raw water is 0 % and the remaining error to be corrected is small. Thus, the amount of the more expensive raw water consumed is very small. No separate circulation is required for the feed of raw water.

The price of the arrangement disclosed hardly differs at all from the price of the conventional dilution headbox. The proposed arrangement uses half the number of expensive dilution valves and actuators.

Thus, mixing units are prior known in which dilution water and stock passed from the inlet header of the headbox are mixed and the combined flow is passed further onwards in the headbox and onto a forming wire. Points of supply of dilution liquid

are situated in different positions of width across the headbox and, thus, depending on the density of the dilution points placed across the width of the headbox, desired resolution is obtained for control of the basis weight of the web.

Thus, this application proposes using dilution in at least two stages. Coarse control of the basis weight profile is carried out in the first stage of dilution and fine control is carried out in the second stage of dilution. White water is used as dilution water in the first stage and the valves are arranged with a less dense spacing in the first stage than in the second control stage in which the valves are arranged with a denser spacing than in the first dilution stage. An advantage of the arrangement is that the valves of the second stage can have a cònstruction that demands less precision and thus be less expensive than the valves of the first stage. They do not clog because fibre-free dilution water is used in the second stage. The valves can thus contain smaller ducts. They do not demand much space.

Within the scope of the invention, it is also possible to use control with three or more stages, but the most advantageous control arrangement is two-stage adjustment of the dilution liquid.

The headbox structure of the paper or board machine can advantageously be as follows:

a) stock is passed into a stock inlet header which tapers towards its outlet end in a conventional manner,
b) the stock flow is passed from the stock inlet header into a tube bank and further through the tube bank into an intermediate chamber,
c) the stock flow is passed from the intermediate chamber further into a turbulence generator and from the turbulence generator further through a slice cone onto a forming wire.

In the following, the invention will be described with reference to some

advantageous embodiments of the invention shown in the figures of the accompanying drawings, to which the invention is, however, not intended to be exclusively confined.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a graph showing uncorrected basis weight profile of stock passed from an inlet header J_1 across the width of the machine.

FIG. 1B is a graph showing a basis weight profile after the valves V_1,V_2 ... controlling the basis weight profile.

FIG. 1C is a graph showing a corrected basis weight profile of stock after the second dilution stage.

FIG. 2 shows a headbox of a paper or board machine in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In accordance with the invention, the valves of the first dilution stage are located in connection with the tube bank and the valves of the second dilution stage are located after the intermediate chamber in connection with the turbulence generator.

Figures 1A--1C show the method according to the invention in stages. The graph F_1 in Fig. 1A represents an uncorrected basis weight profile of stock passed from an inlet header J_1 across the width of the machine. In the first dilution stage, coarse control of the basis weight profile is carried out by means of valves V_1, V_2... of the first dilution stage.

The graph F_1' in Fig. 1B shows a basis weight profile after the valves V_1, V_2 ... controlling the basis weight profile.

In Fig. 1C, the graph F_2 shows a corrected basis weight profile of stock after the second dilution stage. Dilution valves V_1', V_2'... of the second dilution stage are placed, for example, in connection with a turbulence generator. The graph F_2 shows the basis weight profile in the stock flow across the width of the machine after adjustment carried out by the valves V_1', V_2'... of the second stage.

In Figs. 1A--1C, the horizontal coordinate X represents headbox operation and the vertical coordinate Y represents the basis weight. A basis weight deviation from the zero level, i.e. a basis weight error, occurring in the stock and further in the web can be read from the vertical coordinate Y. The basis weight profile can be measured from the stock flow, but the easiest way to measure the basis weight is to measure it from a finished paper or board web.

Figure 2 shows a headbox of a paper or board machine in accordance with the invention.

In Fig. 1A, the first graph F_1 shows control in the first dilution stage. The graph F_1 depicts a basis weight variation which occurs in the stock before the control valves V_1,V_2,V_3... of the first stage.

In Fig. 1A, the graph F_1 shows a basis weight variation which occurs in the stock M_1. An average basis weight variation is further shown by the graph F_{10}. As seen in the graph F_{10}, in the basis weight there is firstly a shape error and secondly a local error. Said shape error is corrected by means of the control valves V_1, V_2... the first dilution stage I such that the graph F_{10} becomes straight. The local errors are rectified by means of the control valves V_1', V_2'... in the basis weight adjustment of the second stage II.

The graph F_1' of Fig. 1B illustrates the situation after the first stage, in which connection control of the basis weight of the stock M_1 has been accomplished by introduction of dilution liquid. In the graph, the horizontal coordinate X represents

the cross-direction position of the headbox and the positions of the valves are denoted with V_1', V_2', V_3'... in the horizontal coordinate X. The vertical coordinate Y shows a basis weight error of the stock after the adjustment of the first stage I. Fig. 1C shows the basis weight control of the second dilution stage II. The graph F_2 illustrates the situation after the dilution liquid valves V_1', V_2', V_3'... of the second dilution stage. The graph F_2 is straight and there does not occur any basis weight error any more. In the graph, the horizontal coordinates represent the width of the headbox, and the position of the valves is denoted with V_1', V_2'... at each particular point of the horizontal coordinate X. The vertical coordinate Y shows the basis weight error of the stock. The zero level illustrates a correct constant basis weight situation. White water is used as dilution water in the first stage I, which water may contain fibres and fines/fillers. The dilution of the second stage II is carried out by means of dilution water which does not contain fibres, such as raw water. A benefit in that case is that conventional valves V_1', V_2', V_3'... can be used because there is no risk of the ducts being clogged by fibres.

The dilution water feeds of the kind mentioned can be placed with a denser spacing than those of the current arrangements, the spacing between the valves in dilution control can be reduced from 60 mm to 30 mm. The amount of the dilution water used is small and there is no need for a separate circulation of the dilution water. Consequently, the construction of the arrangement according to the invention is advantageous and it allows a denser spacing to be used between the valves, i.e. higher resolution, i.e. a higher accuracy of control. By using raw water in the adjustment of the second stage it is possible to employ conventional valve arrangements, in which connection the valves can also be placed with a spacing of even 20-30 mm with respect to one another, whereas in the adjustment of the first stage, the control resolution can be changed in the case of said stage so that the valves are disposed, for example, with a spacing of 120 mm with respect to one another instead of, for example, conventional single-stage dilution of 60 mm. Thus, by using the arrangement in accordance with the invention in which the dilution of the first stage employs white water as dilution water and the dilution of the second

stage employs fibre-free dilution water, an overall end result is achieved in which the accuracy of control is better than in conventional single-stage dilution and in which the construction costs with respect to structure have, however, not increased as compared with single-stage dilution.

The coarse control of the basis weight profile is carried out in the first stage of dilution and the fine control thereof is carried out in the second stage of dilution. The dilution water used in the second dilution stage is advantageously raw water or clarified white water. Thus, the dilution water of the second stage contains solids and/or fibres substantially less in percentage terms than the dilution water of the first stage, which is advantageously water taken out of the wire. Most advantageously, the dilution water of the second stage is raw water that does not contain any solids and fillers and fibres.

Fig. 2 shows a headbox 10 of a paper or board machine in accordance with the invention. The headbox comprises a stock inlet header J_1, a tube bank 11 after the stock inlet header, an intermediate chamber 12 after the tube bank, and a turbulence generator 13 after the intermediate chamber, and further a slice cone 14 from which stock M_1 is passed onto a forming wire H_1. In accordance with the invention, dilution of the first stage is carried out in tubes $11a_{1.1}$, $11a_{1.2}$, $11a_{4.1}$, $11a_{4.2}$ ... of the tube bank 11 through valves V_1, V_2, V_3.... White water is passed from a white water inlet header J_2 (arrow L_1) into tubes D_1, D_2, D_3... and through them into the valves V_1, V_2, V_3... and further through said adjustable valves V_1,V_2 ... into the tubes $11a_{1.1}$, $11a_{1.2}$, $11a_{4.1}$, $11a_{4.2}$ ... of the tube bank 11. The valves V_1, V_2, V_3... are located, for example, with a spacing of 120 mm in connection with the headbox having a width of 10 m. The second dilution location, i.e. valves V_1', V_2'... of the second dilution stage II are advantageously located in connection with turbulence pipes $13a_{1.1}$, $13a_{1.2}$, $13a_{1.3}$, $11a_{2.1}$, $13a_{2.2}$, $13a_{2.3}$ of the turbulence generator 13 at different points of width across the headbox. Raw water is passed (arrow L_2) from a raw water inlet header J_3 into a duct D_1',D_2',D_3'... and through the valves V_1', V_2'... further into the pipes $13a_{1.1}$, $13a_{1.2}$, $13a_{1.3}$, $11a_{2.1}$, $13a_{2.2}$, $13a_{2.3}$ of the turbulence generator 13, in which the raw

water is passed into connection with the stock diluted in the first stage. The flow of the stock M_1 is denoted with the arrows S_1 and the flow of the dilution waters is denoted with the arrows L_1 and L_2.

When the dilution liquid is passed into connection with the stock flow in the first dilution stage and in the second stage, the dilution water is passed in the first dilution stage I either into one or more, advantageously all tubes of the tube row of the tube bank 11 at the width point in question. Similarly, in the second dilution stage II, the dilution water can be passed either into one tube of the turbulence generator 13 at the width point in question or into more tubes, advantageously into all tubes at the width point in question.

CLAIMS

See Preliminary Amendment filed simultaneously herewith for claims.

2/pro

Method and apparatus for mixing dilution liquid into a stock flow in a paper or board machine

The invention relates to a method and an apparatus for mixing dilution liquid into a stock flow in a paper or board machine.

With respect to the prior art, we refer to the publications DE 19723861 and FI 901593.

It has become clear that with the development of measuring devices on the market ever higher requirements are set for the accuracy of control of the basis weight profile. Today, the dilution spacing in a so-called dilution headbox is about 32-75 mm, and it is not possible to reduce it any more if fibre-containing white water is used as dilution water, because dilution feed ducts which remain open by means of white water cannot be accommodated between tube rows with a dense spacing.

As a solution it is proposed that. when needed, dilution is changed to comprise two stages such that coarse control is carried out by means of white water and fine control is carried out by means of raw water.

The increasing requirement of control accuracy calls for an increasingly denser dilution spacing and, therefore. still narrower dilution feed ducts. If white water is used as dilution water, narrow dilution ducts clog easily. Clogging problems are not encountered with raw water, but its "full-scale use" is not economical and sensible for environmental reasons.

The idea of the two-stage dilution is to correct large basis weight profile errors by a large amount of white water and small profile errors by a small amount of raw water. A good raw water economy is achieved by this means in a paper mill.

Another benefit of the two-stage arrangement is the good possibility of adjusting the basis weight profile. The entire valve control area can be made use of and control valves of an optimum size can be selected for both control operations.

Coarse control is carried out in a tube bank after an inlet header, as in the conventional headbox. In the first dilution stage, the control spacing can be increased, for example, to 120 mm such that one dilution member feeds two tube rows. Course control corrects major errors in the shape of the profile, such as, for example, profile errors arising from web shrinkage. The small errors which remain in the profile after coarse control are rectified by means of fine control dilution in the second stage.

Fine adjustment is carried out as turbulence generator dilution by supplying some or each of the tubes of the turbulence generator with dilution liquid. A very small amount of dilution liquid is needed for rectifying the remaining small errors, so raw water or clarified white water obtained from a fibre recovery unit can be used economically as dilution water in fine control. Since, for example, raw water does not contain contaminating or clogging particles, the dilution ducts can be provided in very narrow spaces. Moreover, the control valves and the actuators operating the valves can be ordinary standard devices available on the market, which devices are considerably less expensive than conventional dilution valves and actuators.

Minimum local dilution with raw water can be almost 0 % and maximum local dilution need not be high because the consistency of raw water is 0 % and the remaining error to be corrected is small. Thus, the amount of the more expensive raw water consumed is very small. No separate circulation is required for the feed of raw water.

The price of the arrangement disclosed hardly differs at all from the price of the conventional dilution headbox. The proposed arrangement uses half the number of expensive dilution valves and actuators.

Thus, mixing units are prior known in which dilution water and stock passed from the inlet header of the headbox are mixed and the combined flow is passed further onwards in the headbox and onto a forming wire. Points of supply of dilution liquid are situated in different positions of width across the headbox and, thus, depending on the density of the dilution points placed across the width of the headbox, desired resolution is obtained for control of the basis weight of the web.

The method and the apparatus according to the invention are characterized in what is set forth in the claims.

Thus, this application proposes using dilution in at least two stages. Coarse control of the basis weight profile is carried out in the first stage of dilution and fine control is carried out in the second stage of dilution. White water is used as dilution water in the first stage and the valves are arranged with a less dense spacing in the first stage than in the second control stage in which the valves are arranged with a denser spacing than in the first dilution stage. An advantage of the arrangement is that the valves of the second stage can have a construction that demands less precision and thus be less expensive than the valves of the first stage. They do not clog because fibre-free dilution water is used in the second stage. The valves can thus contain smaller ducts. They do not demand much space.

Within the scope of the invention, it is also possible to use control with three or more stages, but the most advantageous control arrangement is two-stage adjustment of the dilution liquid.

The headbox structure of the paper or board machine can advantageously be as follows:

a) stock is passed into a stock inlet header which tapers towards its outlet end in a conventional manner,

b) the stock flow is passed from the stock inlet header into a tube bank and further through the tube bank into an intermediate chamber,

c) the stock flow is passed from the intermediate chamber further into a turbulence generator and from the turbulence generator further through a slice cone onto a forming wire.

In the following, the invention will be described with reference to some advantageous embodiments of the invention shown in the figures of the accompanying drawings, to which the invention is, however, not intended to be exclusively confined.

In accordance with the invention, the valves of the first dilution stage are located in connection with the tube bank and the valves of the second dilution stage are located after the intermediate chamber in connection with the turbulence generator.

Figures 1A—1C show the method according to the invention in stages. The graph F_1 in Fig. 1A represents an uncorrected basis weight profile of stock passed from an inlet header J_1 across the width of the machine. In the first dilution stage, coarse control of the basis weight profile is carried out by means of valves V_1,V_2... of the first dilution stage.

The graph F_1' in Fig. 1B shows a basis weight profile after the valves V_1,V_2 ... controlling the basis weight profile.

In Fig. 1C, the graph F_2 shows a corrected basis weight profile of stock after the second dilution stage. Dilution valves V_1',V_2'... of the second dilution stage are placed, for example, in connection with a turbulence generator. The graph F_2 shows the basis weight profile in the stock flow across the width of the machine after adjustment carried out by the valves V_1',V_2'... of the second stage.

In Figs. 1A—1C, the horizontal coordinate X represents headbox operation and the vertical coordinate Y represents the basis weight. A basis weight deviation from the zero level, i.e. a basis weight error, occurring in the stock and further in the web can be read from the vertical coordinate Y. The basis weight profile can be

measured from the stock flow, but the easiest way to measure the basis weight is to measure it from a finished paper or board web.

Figure 2 shows a headbox of a paper or board machine in accordance with the invention.

In Fig. 1A, the first graph F_1 shows control in the first dilution stage. The graph F_1 depicts a basis weight variation which occurs in the stock before the control valves $V_1,V_2,V_3...$ of the first stage.

In Fig. 1A, the graph F_1 shows a basis weight variation which occurs in the stock M_1. An average basis weight variation is further shown by the graph F_{10}. As seen in the graph F_{10}, in the basis weight there is firstly a shape error and secondly a local error. Said shape error is corrected by means of the control valves $V_1,V_2...$ of the first dilution stage I such that the graph F_{10} becomes straight. The local errors are rectified by means of the control valves $V_1',V_2'...$ in the basis weight adjustment of the second stage II.

The graph F_1' of Fig. 1B illustrates the situation after the first stage, in which connection control of the basis weight of the stock M_1 has been accomplished by introduction of dilution liquid. In the graph, the horizontal coordinate X represents the cross-direction position of the headbox and the positions of the valves are denoted with $V_1',V_2',V_3'...$ in the horizontal coordinate X. The vertical coordinate Y shows a basis weight error of the stock after the adjustment of the first stage I.

Fig. 1C shows the basis weight control of the second dilution stage II. The graph F_2 illustrates the situation after the dilution liquid valves $V_1',V_2',V_3'...$ of the second dilution stage. The graph F_2 is straight and there does not occur any basis weight error any more. In the graph, the horizontal coordinates represent the width of the headbox, and the position of the valves is denoted with $V_1',V_2'...$ at each particular point of the horizontal coordinate X. The vertical coordinate Y shows the basis weight error of the stock. The zero level illustrates a correct constant basis weight

situation. White water is used as dilution water in the first stage I, which water may contain fibres and fines/fillers. The dilution of the second stage II is carried out by means of dilution water which does not contain fibres, such as raw water. A benefit in that case is that conventional valves V_1',V_2',V_3'... can be used because there is no risk of the ducts being clogged by fibres.

The dilution water feeds of the kind mentioned can be placed with a denser spacing than those of the current arrangements, the spacing between the valves in dilution control can be reduced from 60 mm to 30 mm. The amount of the dilution water used is small and there is no need for a separate circulation of the dilution water. Consequently, the construction of the arrangement according to the invention is advantageous and it allows a denser spacing to be used between the valves, i.e. higher resolution, i.e. a higher accuracy of control. By using raw water in the adjustment of the second stage it is possible to employ conventional valve arrangements, in which connection the valves can also be placed with a spacing of even 20-30 mm with respect to one another, whereas in the adjustment of the first stage, the control resolution can be changed in the case of said stage so that the valves are disposed, for example, with a spacing of 120 mm with respect to one another instead of, for example, conventional single-stage dilution of 60 mm. Thus, by using the arrangement in accordance with the invention in which the dilution of the first stage employs white water as dilution water and the dilution of the second stage employs fibre-free dilution water, an overall end result is achieved in which the accuracy of control is better than in conventional single-stage dilution and in which the construction costs with respect to structure have, however, not increased as compared with single-stage dilution.

The coarse control of the basis weight profile is carried out in the first stage of dilution and the fine control thereof is carried out in the second stage of dilution. The dilution water used in the second dilution stage is advantageously raw water or clarified white water. Thus, the dilution water of the second stage contains solids and/or fibres substantially less in percentage terms than the dilution water of the first stage, which is advantageously water taken out of the wire. Most advantageously,

the dilution water of the second stage is raw water that does not contain any solids and fillers and fibres.

Fig. 2 shows a headbox 10 of a paper or board machine in accordance with the invention. The headbox comprises a stock inlet header J_1, a tube bank 11 after the stock inlet header, an intermediate chamber 12 after the tube bank, and a turbulence generator 13 after the intermediate chamber. and further a slice cone 14 from which stock M_1 is passed onto a forming wire H_1. In accordance with the invention, dilution of the first stage is carried out in tubes $11a_{1.1}$,$11a_{1.2}$,$11a_{4.1}$,$11a_{4.2}$ ... of the tube bank 11 through valves V_1,V_2,V_3.... White water is passed from a white water inlet header J_2 (arrow L_1) into tubes D_1,D_2,D_3... and through them into the valves V_1,V_2,V_3... and further through said adjustable valves V_1,V_2 ... into the tubes $11a_{1.1}$,$11a_{1.2}$,$11a_{4.1}$,$11a_{4.2}$ ... of the tube bank 11. The valves V_1,V_2,V_3... are located, for example, with a spacing of 120 mm in connection with the headbox having a width of 10 m. The second dilution location, i.e. valves V_1',V_2'... of the second dilution stage II are advantageously located in connection with turbulence pipes $13a_{1.1}$,$13a_{1.2}$,$13a_{1.3}$,$11a_{2.1}$,$13a_{2.2}$,$13a_{2.3}$ of the turbulence generator 13 at different points of width across the headbox. Raw water is passed (arrow L_2) from a raw water inlet header J_3 into a duct D_1',D_2',D_3'... and through the valves V_1', V_2'... further into the pipes $13a_{1.1}$,$13a_{1.2}$,$13a_{1.3}$,$11a_{2.1}$,$13a_{2.2}$,$13a_{2.3}$ of the turbulence generator 13, in which the raw water is passed into connection with the stock diluted in the first stage. The flow of the stock M_1 is denoted with the arrows S_1 and the flow of the dilution waters is denoted with the arrows L_1 and L_2.

When the dilution liquid is passed into connection with the stock flow in the first dilution stage and in the second stage, the dilution water is passed in the first dilution stage I either into one or more, advantageously all tubes of the tube row of the tube bank 11 at the width point in question. Similarly, in the second dilution stage II, the dilution water can be passed either into one tube of the turbulence generator 13 at the width point in question or into more tubes, advantageously into all tubes at the width point in question.

AMENDED CLAIMS

[received by the International Bureau on 14 September 2000 (14.09.00); original claims 1-9 replaced by new claims 1-7 (2 pages)]

1. A method for passing dilution water into connection with a stock flow passed from a stock inlet header of a headbox in a paper or board machine, **characterized** in that, in the method, dilution is carried out in at least two stages using in the first dilution stage (I) valves (V_1,V_2,V_3...) fitted with a larger mutual spacing at different points of width across the headbox and passing the dilution water through said valves to desired points of width of the headbox according to the requirement of control of the basis weight of paper or board, and that, in the method, in the second dilution stage (II), dilution water is passed into connection with the stock flow coming from the first dilution stage (I), said dilution water being controlled by means of valves (V_1',V_2'...), which valves (V_1',V_2'...) have been fitted with a denser spacing than the valves (V_1,V_2,V_3...) of the first dilution stage (I), and that coarse control of the basis weight profile of the stock (M_1) is carried out in the first dilution stage (I) and fine control of the basis weight profile of the stock (M_1) is carried out in the second dilution stage (II) across the width of the machine.

2. A method according to claim 1, **characterized** in that in the second stage (II) of dilution, as dilution water is used water the solids, filler or fibre content of which is substantially lower in percentage terms than that of the dilution water of the first stage (I) of dilution.

3. A method according to claim 1 or 2, **characterized** in that the dilution water used in the second dilution stage (II) is raw water or clarified white water.

4. A method according to any one of the preceding claims, **characterized** in that the dilution water of the first stage (I) is white water.

5. A headbox (10) of a paper or board machine which comprises a stock inlet header (J_1) and after that a tube bank (11) and after the tube bank an intermediate chamber (12) and after the intermediate chamber a turbulence generator (13) and after the turbulence

generator a slice cone (14) from which stock is passed further onto a forming wire (H_1), **characterized** in that the apparatus comprises valves (V_1, V_2,V_3...) of a first dilution stage (I), through which valves dilution water is passed into connection with the stock (M_1) passed from the inlet header (J_1) to desired points across the width of the headbox so as to control the basis weight of the web in the first stage (I), and that the headbox comprises valves (V_1',V_2',V_3'...) of a second dilution stage (II), through which valves (V_1',V_2'...) the dilution water of the second stage is passed into connection with the stock (M_1) coming from the first dilution stage (I), and that the valves (V_1,V_2, V_3...) of the first dilution stage (I) are spaced a longer distance from one another than the valves (V_1',V_2',V_3'...) of the second dilution stage (II), in which connection coarse control of the basis weight of the web is carried out by means of the valves (V_1,V_2...) of the first dilution stage (I) and fine control of the basis weight of the web is carried out by means of the valves (V_1',V_2'...) of the second dilution stage (II).

6. A headbox of a paper or board machine according to claim 5, **characterized** in that the dilution water of the first dilution stage (I) is passed into connection with the stock (M_1) passed from the stock inlet header (J_1) in connection with the tube bank (11), and that the dilution water of the second dilution stage (II) is passed into connection with the stock (M_1) coming from the first dilution stage (I) in connection with the turbulence generator (13).

7. A headbox according to claim 5 or 6, **characterized** in that the apparatus comprises an inlet header (J_3) for the dilution water of the second dilution stage (II), said inlet header comprising raw water as dilution water.

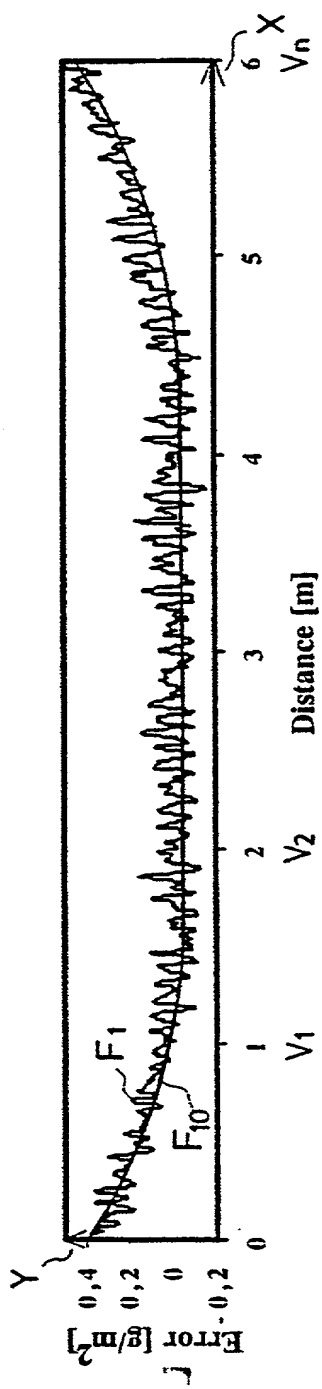

FIG. 1A

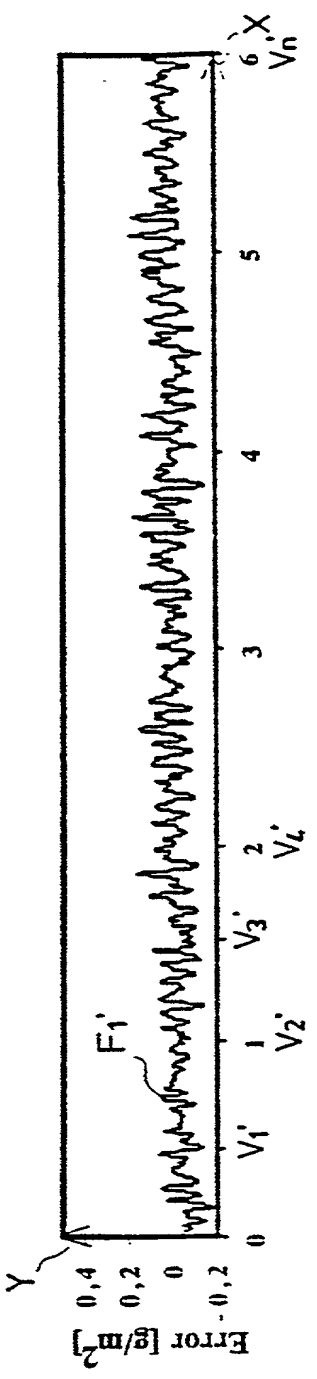

FIG. 1B

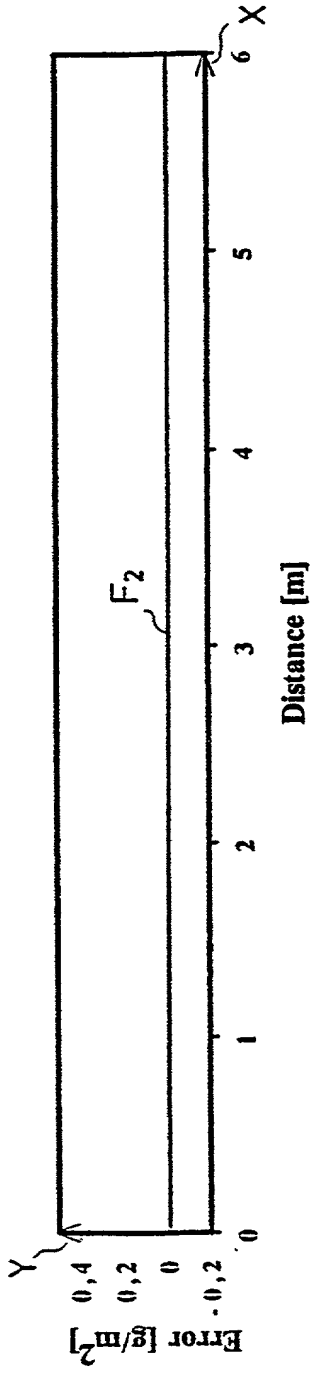

FIG. 1C

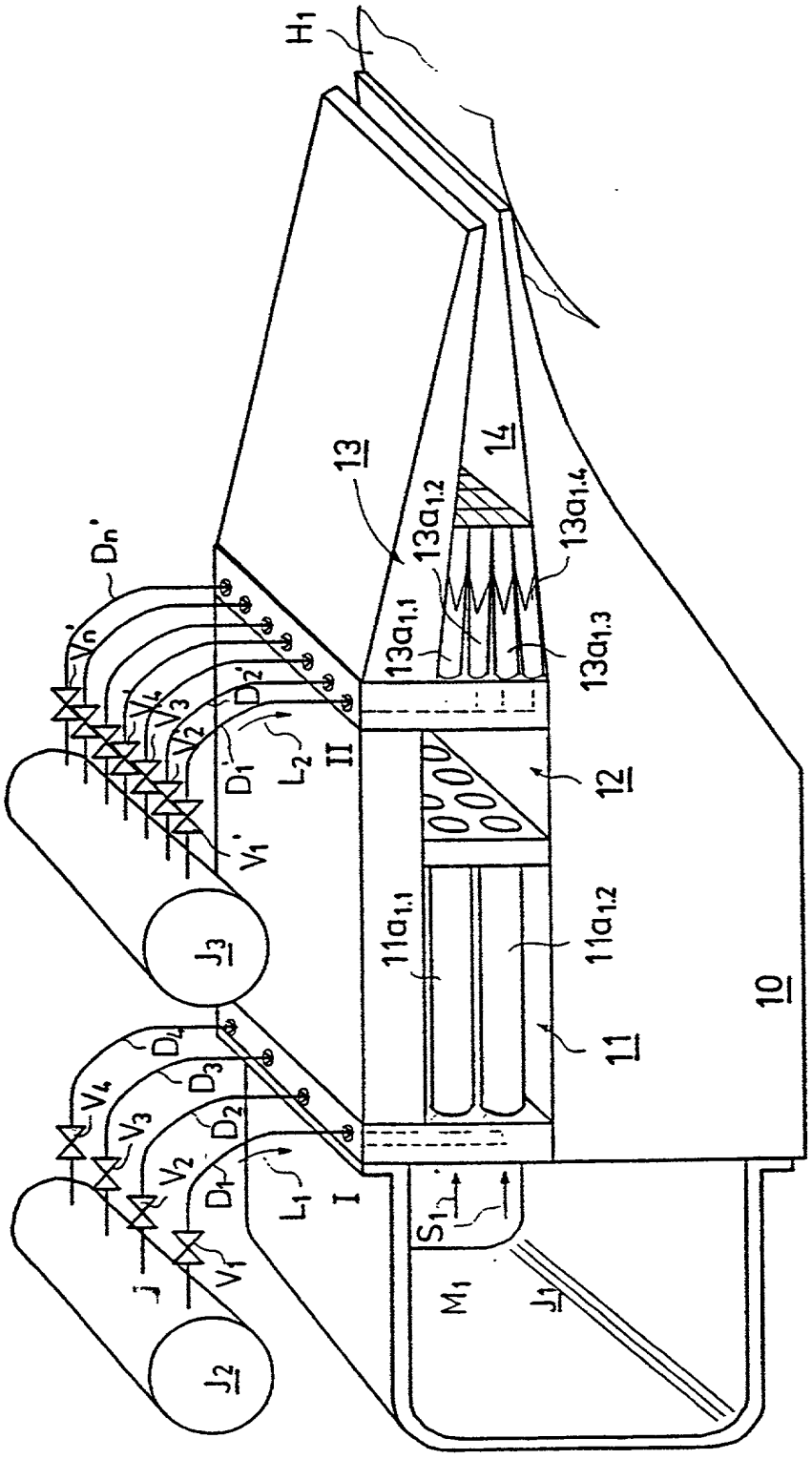
H1
13
14
13a1.2
13a1.4
13a1.1
13a1.3
Dn'
Vn'
V4'
V3'
V2'
V1'
D2'
D1'
L2
II
12
J3
11a1.1
11a1.2
11
10
D4
D3
D2
D1
V4
V3
V2
V1
L1
I
S1
M1
J1
J2

FIG. 2

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☒ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	FORSAL-26
First Named Inventor	Lumiala, Juhana
COMPLETE IF KNOWN	
Application Number	10/009,038
Filing Date	October 26, 2001
Art Unit	
Examiner Name	

As the below named inventor, I hereby declare that:

My residence, mailing address, and citizenship are as stated below next to my name.

I believe I am the original and first inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Method and Apparatus for Mixing Dilution Liquid into a Stock Flow in a Paper or Board Machine

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 04/14/2000 as United States Application Number or PCT International

Application Number PCT/FI00/00320 and was amended on (MM/DD/YYYY) 10/26/2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	Certified Copy Attached? NO
990967	FI	04/28/1999	☐	☐	☒
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

PTO/SB/01 (10-01)
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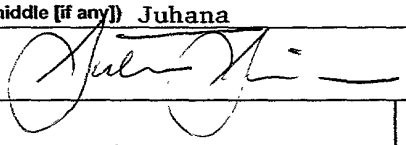
NAME OF SOLE OR FIRST INVENTOR : [ ] A petition has been filed for this unsigned inventor

Given Name (first and middle [if any]) Juhana | Family Name or Surname Lumiala

Inventor's Signature  | Date 6. Nov, 2001

Residence: City Jyväskylä | State | Country FIX FI | Citizenship FI

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City Jyväskylä | State | ZIP FIN-40520 | Country Finland

NAME OF SECOND INVENTOR: [ ] A petition has been filed for this unsigned inventor

Given Name (first and middle [if any]) | Family Name or Surname

Inventor's Signature | Date

Residence: City | State | Country | Citizenship

Mailing Address

City | State | ZIP | Country

[ ] Additional inventors are being named on the ____supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.

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Application Number	PCT/FI00/00320
Filing Date	April 14, 2000
First Named Inventor	Lumiala, Juhana
Title	Method and Apparatus...
Group Art Unit	
Examiner Name	
Attorney Docket Number	FORSAL-26

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Country					
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[X] Applicant/Inventor.

[ ] Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

SIGNATURE of Applicant or Assignee of Record

Name	Juhana Lumiala
Signature	
Date	6 NOV 2001

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

[X] *Total of 1 forms are submitted.

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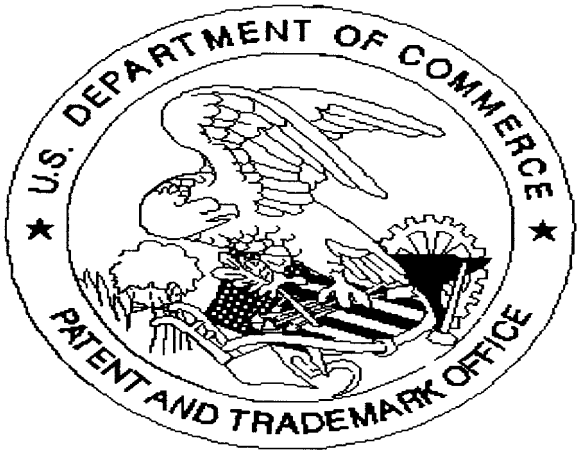

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